| Notice of Allowability | Application No. 09/329,889 | Applicant(s) BOUSSAC ET AL. | |
|---|---|---|---|
| | Examiner Kandasamy Thangavelu | Art Unit 2123 | |

***-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--***

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *January 26, 2005*.
2. ☒ The allowed claim(s) is/are *25,28,30,31,33,35,36,38 and 40-42*.
3. ☒ The drawings filed on *26 January 2005* are accepted by the Examiner.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   a) ☐ All b) ☐ Some* c) ☐ None of the:
   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
**THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.**

5. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.
6. ☐ CORRECTED DRAWINGS ( as "replacement sheets") must be submitted.
   (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review ( PTO-948) attached
   1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
   (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   **Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).**
7. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

**Attachment(s)**

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
3. ☐ Information Disclosure Statements (PTO-1449 or PTO/SB/08), Paper No./Mail Date _____
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application (PTO-152)
6. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
7. ☒ Examiner's Amendment/Comment
8. ☒ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____.

KEVIN J. TESKA
SUPERVISORY
PATENT EXAMINER

## DETAILED ACTION

### *Introduction*

1. This communication is in response to the Applicants' communication dated January 26, 2005. Claims 25, 28, 30, 31, 33, 35, 36, 38 and 40-42 of the application are pending.

### *Drawings*

2. The amendments to the drawings filed on January 26, 2005 are accepted.

### *Examiner's Amendment*

3. Authorization for this examiner's amendment was given in a telephone interview with Mr. James Mahon on March 25, 2005.

An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

4. In the amendment to the specification, appearing in the amendment on Page 2, Para 3, Lines 9-10, "Free neighborhood of a polyhedral object includes tangent zones and material zones, traces by some of the edges and triangles of the polyhedron"

has been changed to

-- Free neighborhood of a polyhedral object includes tangent zones and material zones, traced by some of the edges and triangles of the polyhedron signal--.

In the specification, Page 7, Para 6, Lines 1-2, "Triangles included in the free neighborhood of a 2-D edge can be represented by a half sphere 510"

has been changed to

-- The free neighborhood of a triangle of a 3-D object can be represented by a half sphere 510--.

In the claims:

Claim 35, Lines 1-2, "A computer program residing on a computer-readable medium, the program comprising instructions for causing the computer to:"

has been changed to

-- A computer program residing on a computer-readable medium, the program comprising instructions which when executed on a computer cause the swept volume of a real world object to be generated, the instructions causing the computer to --.

Claim 39 deleted.

## ***Reasons for Allowance***

5. Claims 25, 28, 30, 31, 33, 35, 36, 38 and 40-42 of the application are allowed over prior art of record.

6. The following is an Examiner's statement of reasons for the indication of allowable subject matter:

The closest prior art of record shows:

(1) in robot motion planning there is need for collision detection; a fast computation technique is presented for exact distance computation and interference detection for translationally swept bodies; the technique is extended for bodies swept with a rotational component; the bodies are represented by boundaries composed of convex polygons and unions of polygons; the technique is based on hierarchical geometric representation and several geometric primitives; the boundary of the body is represented by a bounding volume hierarchy; the hierarchy is a binary tree whose nodes contain a convex polygon or polyhedron; the convex hull of the vertices of the polyhedron and their images under translation is equal to the swept hull of the polyhedron; so Gilbert's algorithm is used to compute the distance between the volumes swept by two polygons or polyhedron (**Xaviera,** "Fast swept-volume distance for robust collision detection", IEEE 1997`);

(2) the automatic computation of view points for monitoring objects and features in an active robot work cell; the computation includes computation of volumes swept by polyhedral

objects moving through space; the swept volume algorithm must produce polyhedral models of the swept volumes; the process computes polyhedral approximations to the volumes swept by moving polyhedral objects; the volumes swept by a polygon moving in 3-D space is bounded by the ruled surfaces swept by the moving edges of the polygon, and copies of the polygon at its initial and final positions (**Abrams et al.,** , "swept volumes and their use in viewpoint computation in robot work-cells", IEEE 1995); and

(3) a swept volume is the space occupied by a geometric model as it travels along an arbitrary trajectory; swept volumes play an important role in computer aided designs, including geometric modeling, cutter path generation and spatial path planning; in robot motion planning, swept volume is used to evaluate the paths which would not interfere with the motion of the robot; the system to generate swept volumes using implicit modeling technique; a geometric model and a trajectory defined by a sequence of continuous transformations is acquired; the volume occupied by the model as it travels along the trajectory is computed; the implicit model is generated from the original geometric model; the implicit model is swept according to a swept trajectory (**Schroeder et al.,** U.S. Patent 5,542,036).

6.1 Applicants' first set of claims consists of Claims 25, 28 and 30.

Independent Claim 25 is directed to a method for use in calculation of a swept volume of a computer generated model of a real-world object. The claim identifies the uniquely distinct features of:

"<u>determining a subset of the edges such that each edge in said subset has a trajectory through a corresponding first zone in which motion of the corresponding edge comprises motion</u>

on the boundary of the modeled swept volume during motion of the modeled object from a current position to a next position, where each such edge's corresponding first zone comprising a region external to the material of the modeled object and bounded by a planar extension of the triangles that join at said edge",

"determining a subset of the triangles such that each triangle in said subset has a trajectory through its corresponding second zone during motion of the modeled object from a preceding position to a current position and from the current position to a next position; and where each such triangle's second zone comprises a zone represented by a half sphere, said half sphere comprising a flat face that is planar with said triangle and said half sphere extending interior to the modeled object; and said second zone representing a space that had been occupied by at least a portion of the modeled object when the modeled object was positioned at said preceding position" and

"generating a trace of the motion of said subset of edges between said current and said next positions, and constructing a representation of the swept volume from the generated traces of the motion of said subset of edges, wherein constructing a representation of the swept volume further comprises bounding the swept volume at each of said current positions in said series by said subset of triangles associated with each such current position".

Because the closest prior art fails to teach or fairly suggest determining a subset of the edges such that each edge in said subset has a trajectory through a corresponding first zone in which motion of the corresponding edge comprises motion on the boundary of the modeled swept volume during motion of the modeled object from a current position to a next position,

where each such edge's corresponding first zone comprising a region external to the material of the modeled object and bounded by a planar extension of the triangles that join at said edge; determining a subset of the triangles such that each triangle in said subset has a trajectory through its corresponding second zone during motion of the modeled object from a preceding position to a current position and from the current position to a next position; and where each such triangle's second zone comprises a zone represented by a half sphere, said half sphere comprising a flat face that is planar with said triangle and said half sphere extending interior to the modeled object; and said second zone representing a space that had been occupied by at least a portion of the modeled object when the modeled object was positioned at said preceding position and generating a trace of the motion of said subset of edges between said current and said next positions, and constructing a representation of the swept volume from the generated traces of the motion of said subset of edges, wherein constructing a representation of the swept volume further comprises bounding the swept volume at each of said current positions in said series by said subset of triangles associated with each such current position, as claimed by the Applicants, Claims 25, 28 and 30 are deemed novel and allowable.

6.2 Applicants' second set of claims consists of Claims 31 and 33.

Independent Claim 31 is directed to a computer system for use in computing a swept volume for a model of a real-world object. The claim identifies the uniquely distinct features of:

"whereby for each of a series of sequential positions of the modeled object as represented by the matrices a subset of the edges is determined such that each edge in said subset has a trajectory through a corresponding first zone in which motion of the corresponding edge

comprises motion on the boundary of the modeled swept volume during motion of the modeled object from a current position to a next position and where each such edge's corresponding first zone comprises a region external to the material of the modeled object and bounded by a planar extension of the triangles that join at said edge"

"a subset of the triangles is determined such that each triangle in said subset has a trajectory through its corresponding second zone during motion of the modeled object from a preceding position to a current position and from the current position to a next position and where each such triangle's second zone comprises a zone represented by a half sphere, said half sphere comprising a flat face that is planar with said triangle and said half sphere extending interior to a space that had been occupied by at least a portion of the modeled object when the modeled object was positioned at said preceding position" and

"traces are generated by the motion of the subset of edges during motion between a current and a next position; and a representation of the swept volume is constructed from the traces of the subset of edges and bounded at each of said current positions in said series by said subset of triangles associated with each such current position".

Because the closest prior art fails to teach or fairly suggest whereby for each of a series of sequential positions of the modeled object as represented by the matrices a subset of the edges is determined such that each edge in said subset has a trajectory through a corresponding first zone in which motion of the corresponding edge comprises motion on the boundary of the modeled swept volume during motion of the modeled object from a current position to a next position and where each such edge's corresponding first zone comprises a region external to the material of

the modeled object and bounded by a planar extension of the triangles that join at said edge; a subset of the triangles is determined such that each triangle in said subset has a trajectory through its corresponding second zone during motion of the modeled object from a preceding position to a current position and from the current position to a next position and where each such triangle's second zone comprises a zone represented by a half sphere, said half sphere comprising a flat face that is planar with said triangle and said half sphere extending interior to a space that had been occupied by at least a portion of the modeled object when the modeled object was positioned at said preceding position; and traces are generated by the motion of the subset of edges during motion between a current and a next position; and a representation of the swept volume is constructed from the traces of the subset of edges and bounded at each of said current positions in said series by said subset of triangles associated with each such current position, as claimed by the Applicants, Claims 31 and 33 are deemed novel and allowable.

6.3 Applicants' third set of claims consists of Claim 35.

Independent Claim 35 is directed to a computer program residing on a computer-readable medium, the program comprising instructions which when executed on a computer cause the swept volume of a real world object to be generated. The claim identifies the uniquely distinct features of:

"for each of a series of sequential positions of the modeled object as represented by the matrices, determine a subset of the edges such that each edge in said subset has a trajectory through a corresponding first zone in which motion of the corresponding edge comprises motion on the boundary of the modeled swept volume during motion of the modeled object from a

current position to a next position and where each such edge's corresponding first zone comprising a region external to the material of the modeled object and bounded by a planar extension of the triangles that join at said edge",

" determine a subset of the triangles such that each triangle in said subset has a trajectory through its corresponding second zone during motion of the modeled object from a preceding position to a current position and from the current position to a next position where each such triangle's second zone comprises a zone represented by a half sphere, said half sphere comprising a flat face that is planar with said triangle and said half sphere extending interior to a space that had been occupied by at least a portion of the modeled object when the modeled object was positioned at said preceding position" and

"generate traces of the motion of the subset of edges during motion between a current and a next position; and construct a representation of the swept volume from the traces of the subset of edges and bounded at each of said current positions in said series by said subset of triangles associated with each such current position".

Because the closest prior art fails to teach or fairly suggest for each of a series of sequential positions of the modeled object as represented by the matrices, determine a subset of the edges such that each edge in said subset has a trajectory through a corresponding first zone in which motion of the corresponding edge comprises motion on the boundary of the modeled swept volume during motion of the modeled object from a current position to a next position and where each such edge's corresponding first zone comprising a region external to the material of the modeled object and bounded by a planar extension of the triangles that join at said edge,

determine a subset of the triangles such that each triangle in said subset has a trajectory through its corresponding second zone during motion of the modeled object from a preceding position to a current position and from the current position to a next position where each such triangle's second zone comprises a zone represented by a half sphere, said half sphere comprising a flat face that is planar with said triangle and said half sphere extending interior to a space that had been occupied by at least a portion of the modeled object when the modeled object was positioned at said preceding position; and generate traces of the motion of the subset of edges during motion between a current and a next position; and construct a representation of the swept volume from the traces of the subset of edges and bounded at each of said current positions in said series by said subset of triangles associated with each such current position, as claimed by the Applicants, Claim 35 is deemed novel and allowable.

6.4 Applicants' fourth set of claims consists of Claims 36 and 38.

Independent Claim 36 is directed to a method for use in calculation of a swept volume of a computer generated model of a real-world object. The claim identifies the uniquely distinct features of:

"<u>for each position in the series of sequential positions of the modeled object, determining a subset of the vertices such that each vertex in said subset has a trajectory through a corresponding first zone in which motion of the corresponding edge comprises motion on the boundary of the modeled swept volume during motion of the modeled object from a current position to a next position and where each such edge's corresponding first zone comprising a</u>

region external to the material of the modeled object and bounded by a planar extension of the edges that join at said vertex",

"determining a subset of the edges such that each edge in said subset has a trajectory through its corresponding second zone during motion of the modeled object from a preceding position to a current position and from the current position to a next position and where each such edge's second zone comprises a material zone represented by a half circle, said half circle comprising a flat face that is aligned along said edge, said edge being elements of a tessellated representation of modeled real-world object, and said half circle extending interior to a space that had been occupied by at least a portion of the modeled object when the modeled object was positioned at said preceding position" and

"generating a trace of the motion of said subset of vertices between said current and said next positions, and constructing a representation of the swept volume from the generated traces of the motion of said subset of vertices and edges".

Because the closest prior art fails to teach or fairly suggest for each position in the series of sequential positions of the modeled object, determining a subset of the vertices such that each vertex in said subset has a trajectory through a corresponding first zone in which motion of the corresponding edge comprises motion on the boundary of the modeled swept volume during motion of the modeled object from a current position to a next position and where each such edge's corresponding first zone comprising a region external to the material of the modeled object and bounded by a planar extension of the edges that join at said vertex, determining a subset of the edges such that each edge in said subset has a trajectory through its corresponding

second zone during motion of the modeled object from a preceding position to a current position and from the current position to a next position and where each such edge's second zone comprises a material zone represented by a half circle, said half circle comprising a flat face that is aligned along said edge, said edge being elements of a tessellated representation of modeled real-world object, and said half circle extending interior to a space that had been occupied by at least a portion of the modeled object when the modeled object was positioned at said preceding position and generating a trace of the motion of said subset of vertices between said current and said next positions, and constructing a representation of the swept volume from the generated traces of the motion of said subset of vertices and edges, as claimed by the Applicants, Claims 36 and 38 are deemed novel and allowable.

6.5 Applicants' fifth set of claims consists of Claims 40 and 41.

Independent Claim 40 is directed to a method for use in calculation of a swept volume of a computer generated model of a real-world object. The claim identifies the uniquely distinct features of:

"<u>for each position in the series of sequential positions of the modeled object, determining a subset of the edges such that each edge in said subset has a trajectory through a corresponding first zone in which motion of the corresponding edge comprises motion on the boundary of the modeled swept volume during motion of the modeled object from a current position to a next position, where each such edge's corresponding first zone comprising a region external to the material of the modeled object and bounded by a planar extension of the triangles that join at said edge</u>"

"determining a subset of the triangles such that, for a current position of each such triangle, motion between that current position and any subsequent or preceding position comprises motion along a trajectory directed through the interior of the modeled object" and

"generating a trace of the motion of said subset of edges between said current and said next positions; and constructing a representation of the swept volume from the generated traces of the motion of said subset of edges wherein constructing a representation of the swept volume further comprises bounding the swept volume at each of said current positions in said series by said subset of triangles associated with each such current position".

Because the closest prior art fails to teach or fairly suggest for each position in the series of sequential positions of the modeled object, determining a subset of the edges such that each edge in said subset has a trajectory through a corresponding first zone in which motion of the corresponding edge comprises motion on the boundary of the modeled swept volume during motion of the modeled object from a current position to a next position, where each such edge's corresponding first zone comprising a region external to the material of the modeled object and bounded by a planar extension of the triangles that join at said edge, determining a subset of the triangles such that, for a current position of each such triangle, motion between that current position and any subsequent or preceding position comprises motion along a trajectory directed through the interior of the modeled object and generating a trace of the motion of said subset of edges between said current and said next positions; and constructing a representation of the swept volume from the generated traces of the motion of said subset of edges wherein constructing a representation of the swept volume further comprises bounding the swept volume

at each of said current positions in said series by said subset of triangles associated with each such current position, as claimed by the Applicants, Claims 40 and 41are deemed novel and allowable.

6.6 Applicants' sixth set of claims consists of Claim 42.

Independent Claim 42 is directed to a method for use in calculation of a swept volume of a computer generated model of a real-world object. The claim identifies the uniquely distinct features of:

"for each position in the series of sequential positions of the modeled object, determining a subset of the edges such that each edge in said subset has a trajectory through a corresponding first zone in which motion of the corresponding edge comprises motion on the boundary of the modeled swept volume during motion of the modeled object from a current position to a next position, where each such edge's corresponding first zone comprising a region external to the material of the modeled object and bounded by a planar extension of the triangles that join at said edge",

"determining a subset of the triangles such that, for a current position of each such triangle, motion between that current position and any subsequent or preceding position comprises motion on a vector directed through the interior of the modeled object and where motion of the triangle along the vector is determined at a representative point on the surface of the triangle, motion of said representative point being used to approximate motion of said triangle" and

"generating a trace of the motion of said subset of edges between said current and said next positions; and constructing a representation of the swept volume from the generated traces of the motion of said subset of edges wherein constructing a representation of the swept volume further comprises bounding the swept volume at each of said current positions in said series by said subset of triangles associated with each such current position".

Because the closest prior art fails to teach or fairly suggest for each position in the series of sequential positions of the modeled object, determining a subset of the edges such that each edge in said subset has a trajectory through a corresponding first zone in which motion of the corresponding edge comprises motion on the boundary of the modeled swept volume during motion of the modeled object from a current position to a next position, where each such edge's corresponding first zone comprising a region external to the material of the modeled object and bounded by a planar extension of the triangles that join at said edge, determining a subset of the triangles such that, for a current position of each such triangle, motion between that current position and any subsequent or preceding position comprises motion on a vector directed through the interior of the modeled object and where motion of the triangle along the vector is determined at a representative point on the surface of the triangle, motion of said representative point being used to approximate motion of said triangle and generating a trace of the motion of said subset of edges between said current and said next positions; and constructing a representation of the swept volume from the generated traces of the motion of said subset of edges wherein constructing a representation of the swept volume further comprises bounding the swept volume at each of said current positions in said series by said subset of triangles associated

with each such current position, as claimed by the Applicants, Claim 42 is deemed novel and allowable.

7. Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Dr. Kandasamy Thangavelu whose telephone number is 571-272-3717. The examiner can normally be reached on Monday through Friday from 8:00 AM to 5:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Kevin Teska, can be reached on 571-272-3716. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to TC 2100 Group receptionist: 571-272-2100.

K. Thangavelu
Art Unit 2123
March 25, 2005

KEVIN J. TESKA
SUPERVISORY
PATENT EXAMINER